USE AND APPLICATIONS OF GPS IN TRANSPORTATION SURVEYS IN CALIFORNIA

CGSIC – 44th MEETING

LONG BEACH, CALIFORNIA

SEPTEMBER 2004

CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

RESPONSIBLE FOR THE DESIGN, CONSTRUCTION, MAINTENANCE, AND OPERATION OF THE CALIFORNIA STATE HIGHWAY SYSTEM, AS WELL AS THAT PORTION OF THE INTERSTATE HIGHWAY SYSTEM WITHIN THE STATE'S BOUNDARIES. ALONE AND IN PARTNERSHIP WITH AMTRAK, CALTRANS IS ALSO INVOLVED IN THE SUPPORT OF INTERCITY RAIL SERVICE IN CALIFORNIA, AND IS A LEADER IN PROMOTING THE USE OF ALTERNATIVE MODES OF TRANSPORTATION.

CALTRANS TODAY

- 15,200-mile state highway system
- 3 intercity rail routes
- 20,000 employees
- ~$10 billion annual budget
- Headquartered in Sacramento
- 12 district offices

CALTRANS SURVEYS

- Surveys staff in all districts
- ~800 surveyors; ~50% licensed
- 110 field crews (3- or 4-person)
- Office of Land Surveys
  - Provides functional management of the Caltrans surveying and right-of-way engineering efforts

GPS AT CALTRANS

- 1986 – Initial receivers
  - Application – control surveys
- 1995 – Initial real-time system
  - Application – evaluate technology
- 1998 – Begin purchase/implementation of real-time systems exclusively
  - Application – everyday survey tool

GPS AT CALTRANS

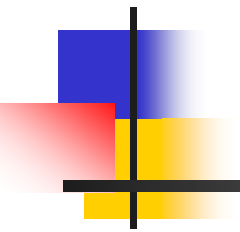
- Today – GPS is an integral part of the Caltrans surveying operations
  - 196 survey/geodetic quality receivers
  - All receivers real-time capable
  - Evaluating real-time networks
- Tomorrow – ?

WHY GPS?

- Safety
  - Line of sight not required; less staff exposed to traffic
- Productivity
  - In the right environment, surveys completed in less time

GPS AT CALTRANS

- Diverse environments from urban to forested to desert
- Jobsites are always along transportation corridors
- GPS is another tool in the surveyors' tool box



AIRBORNE GPS

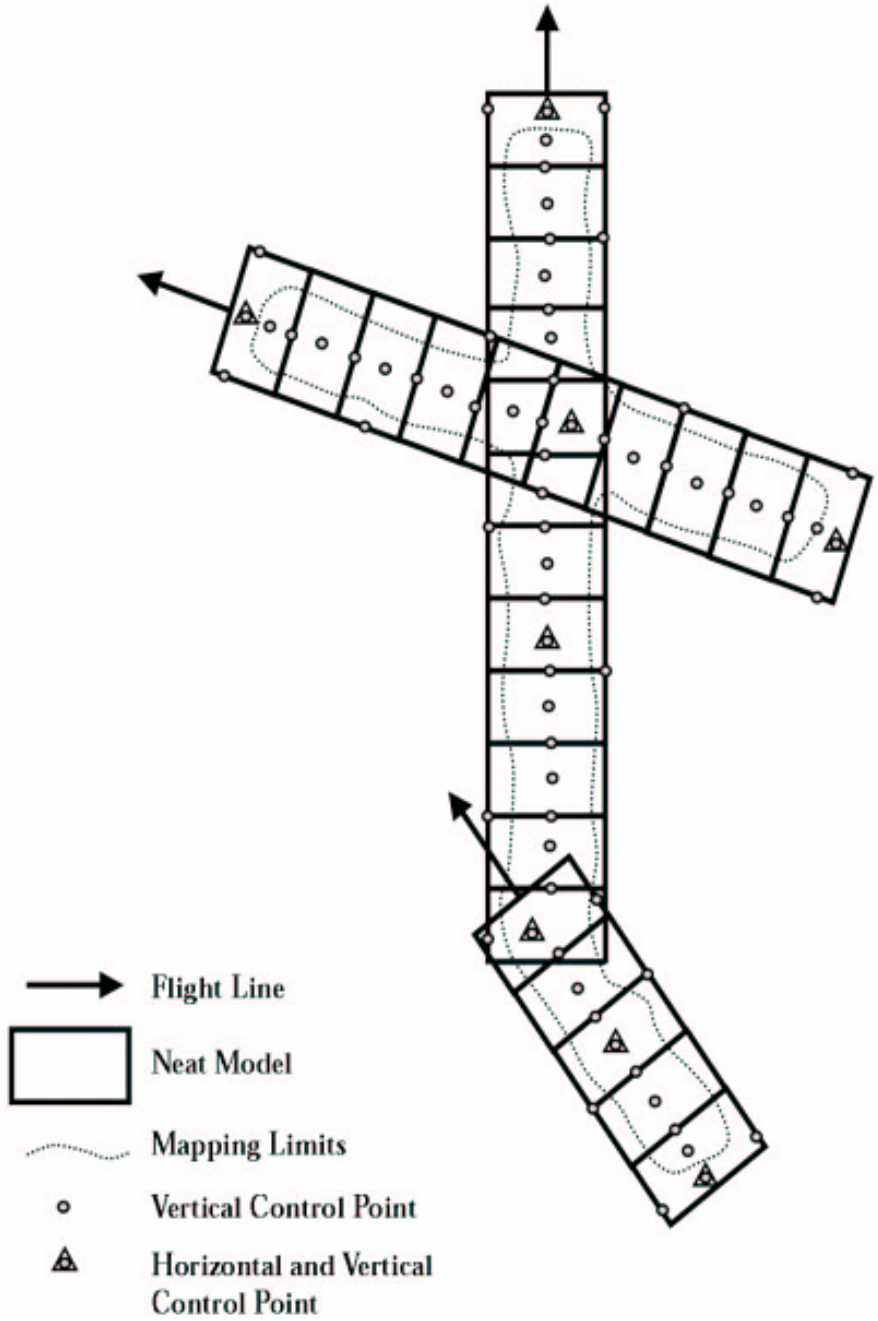
Conventional Photo Control

3 Targets per model along CL

1 Wing Point every 4 models

1 HV Point every 5 models

3rd Order Control



AIRBORNE GPS

- California State University – Fresno, Geomatics Engineering
- Aerial photography consultants
- Trimble Navigation, Ltd.
- Caltrans

AIRBORNE GPS

PROBLEM STATEMENT

Is airborne GPS adequate for Caltrans' standard 1:500 scale mapping with a 0.5m contour interval using strip photography?

AIRBORNE GPS

- Reviewed literature
- Performed statistical analysis of simulated data
- Executed research projects

AIRBORNE GPS

CONCLUSION

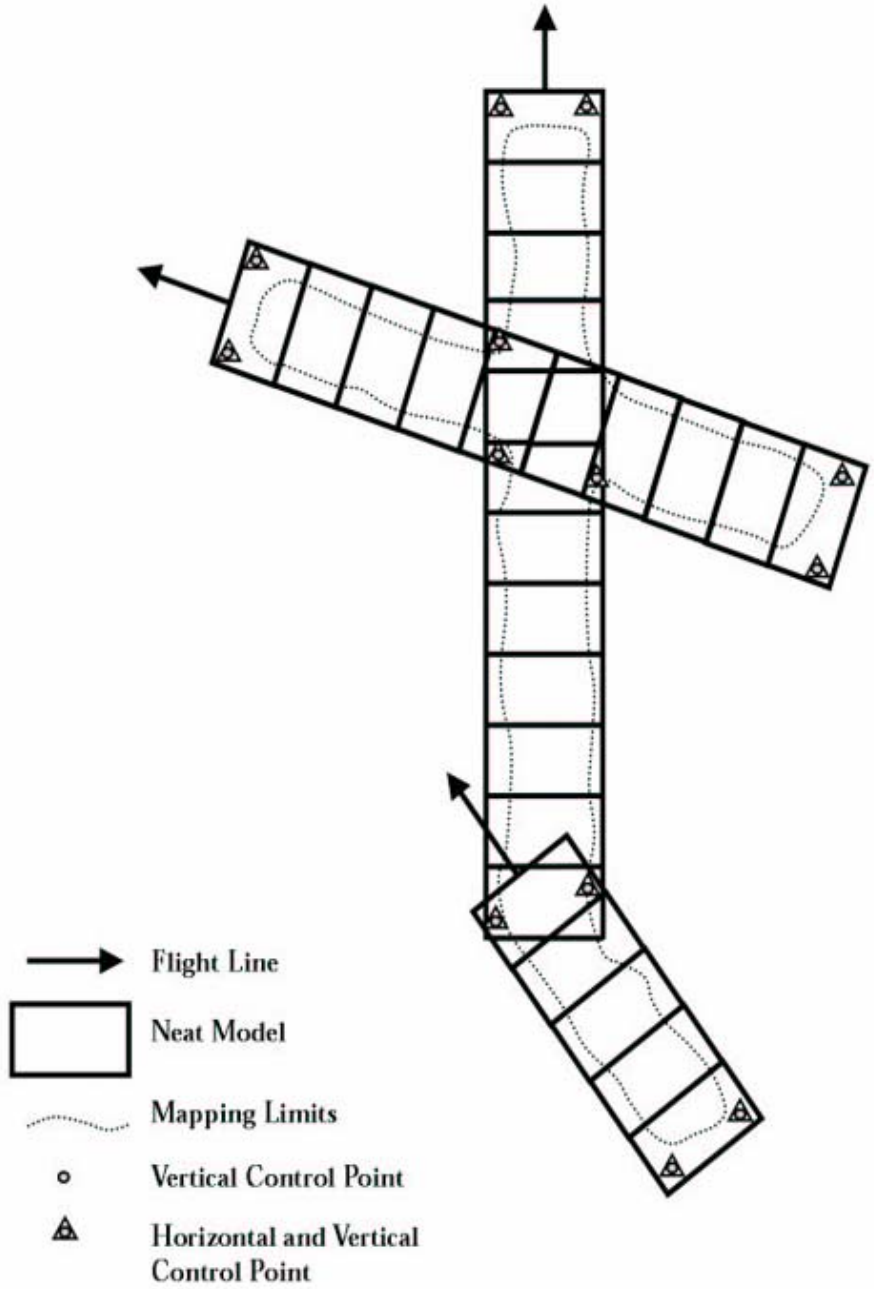
Using post-processed kinematic GPS survey techniques, airborne GPS IS adequate for Caltrans' standard 1:500 scale mapping with a 0.5m contour interval using strip photography

Airborne GPS

Eliminates need for control along CL because the photo center coordinates become knowns rather than unknowns.

Requires a pair of wing points every 6 models.

2nd Order Control



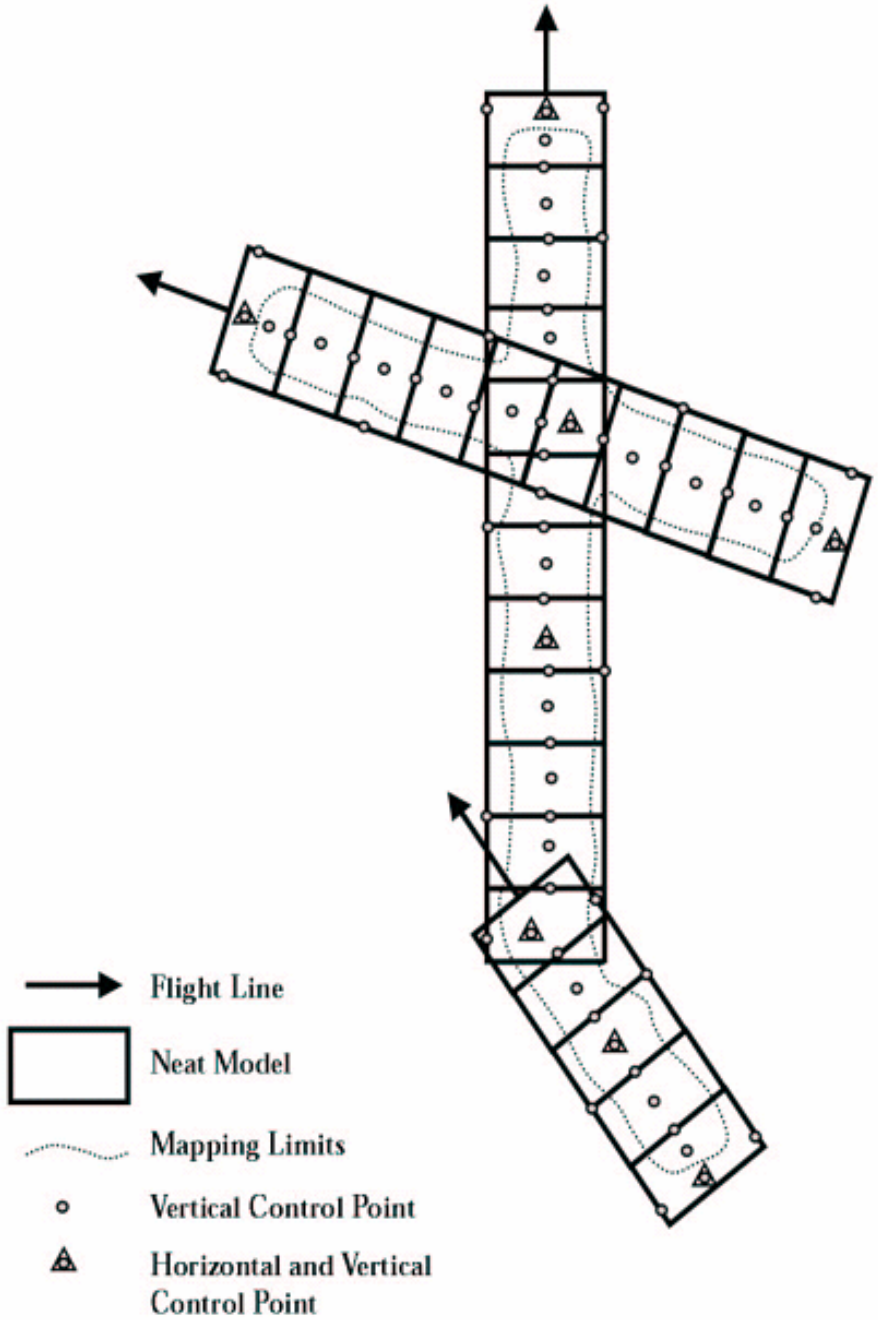
Conventional Photo Control

3 Targets per model along CL

1 Wing Point every 4 models

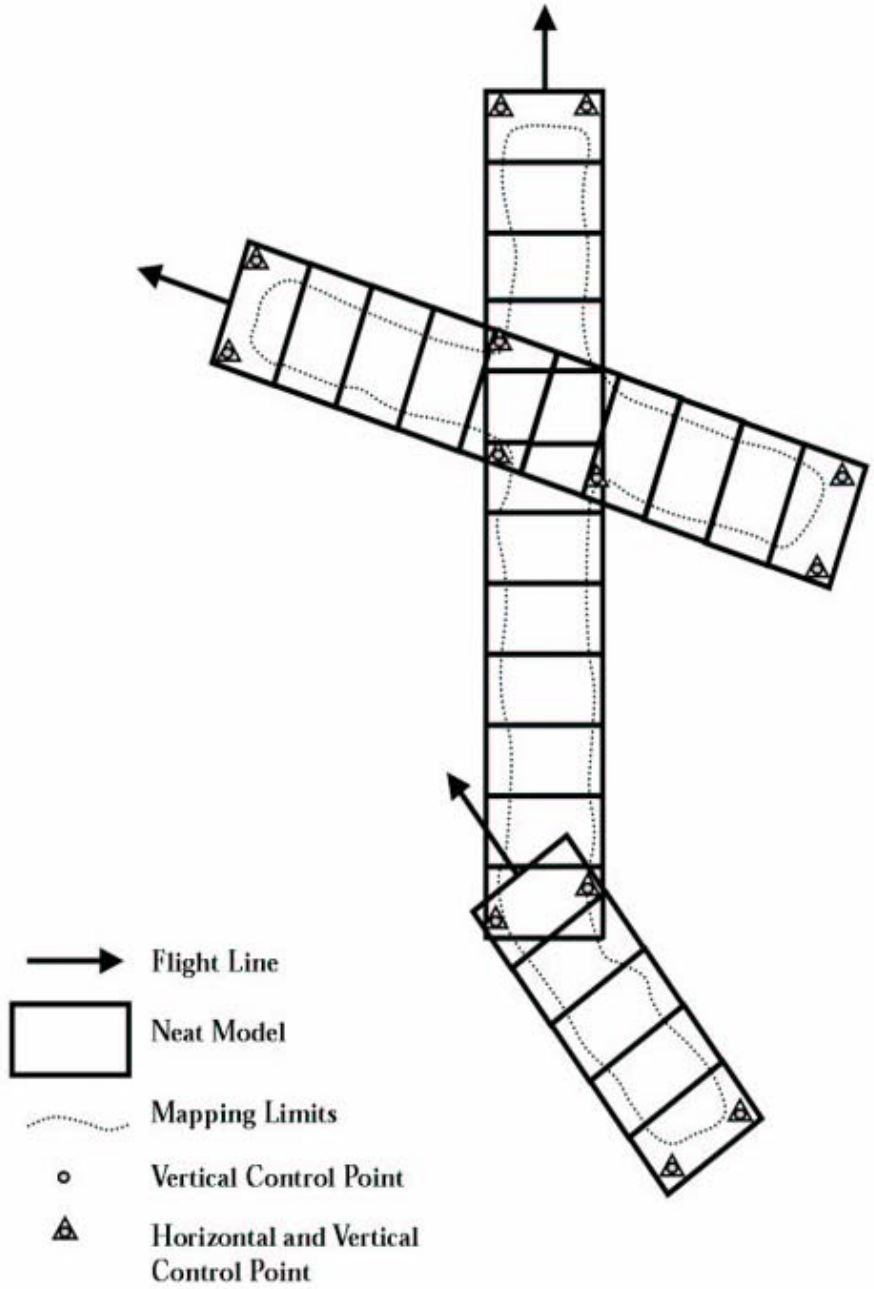
1 HV Point every 5 models

3rd Order Control



Airborne GPS

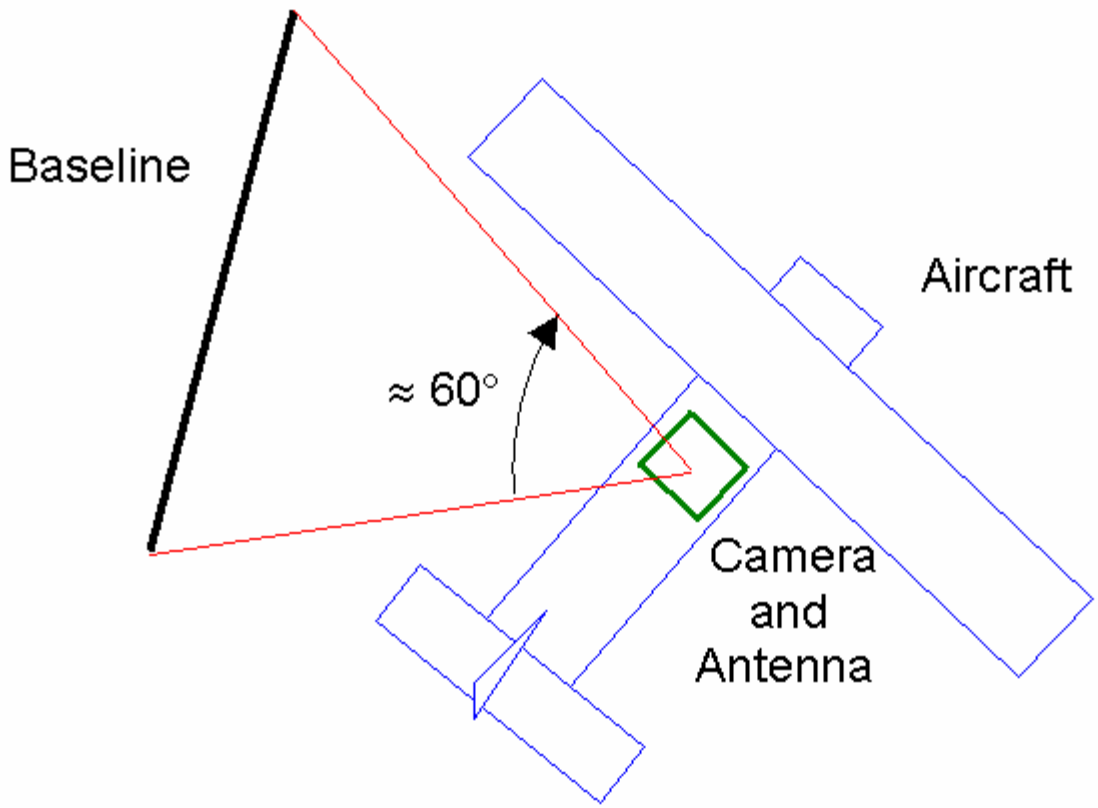
Reduces by 80% the need for on-the-ground photo control



AIRBORNE GPS

- Preparation
  - Relative position of camera and antenna surveyed with conventional equipment
  - Cabling
    - Receiver to antenna
    - Receiver to camera w/event marker

Camera/Antenna Relationship




ISD
Caltrans
13 11:10 AM


Trimble
TAKE UP
13 11:01AM

AIRBORNE GPS

- Mission planning
  - PDOP<=3.0 for entire observation period
  - 5 or more SV's for entire observation period
  - Select base station locations at airport and jobsite

AIRBORNE GPS

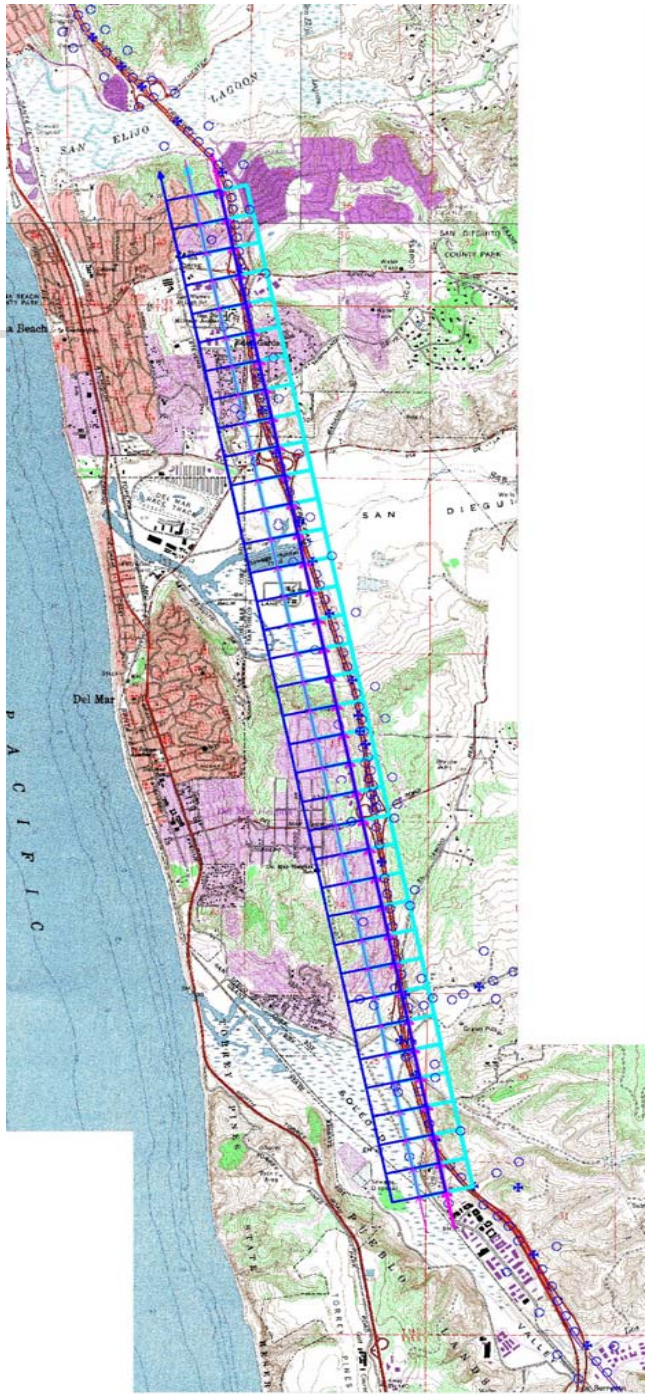
- Mission
  - At airport, aircraft taxis to initialization location
  - Static initialization for 20 min.


13 11:05 AM

Flight Plan

Shows:

- Pilot and camera operator where to acquire images
- Location of ground control targets



AIRBORNE GPS

- Mission completion
  - Aircraft returns to airport, taxis to initialization location
  - Post-mission 20 min. static initialization

AIRBORNE GPS

- Post-processing ABGPS data
  - Forward processing (using pre-flight initialization)
  - Reverse processing (using post-flight initialization)
  - Event interpolation
  - Statistical analysis

AIRBORNE GPS

- Project Adjustment
  - Post-processed kinematic GPS data
  - Event times and interpolated positions to match to exposures
  - Aerotriangulation data for all exposures
  - Camera to antenna offset information
- Data combined and simultaneously adjusted
- Compilation proceeds conventionally

AIRBORNE GPS

CONCLUSION

ABGPS has proven to be an excellent tool in providing photogrammetric mapping for transportation projects and reducing the danger to Caltrans surveyors

QUESTIONS?

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